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Surface drift in the upper centimetres of the water column in short fetches and the behaviour of the diffusive sub-layer from experiments in a wind wave flume

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Ocean surface drift is of great relevance to properly model exchange processes between the ocean and the atmosphere. It is also important to better understand the early stages of surface waves development and their implications in the momentum transfer across the sea surface. In this work we study the the onset of surface drift induced by wind and waves through detailed laboratory measurements in a large wind-wave flume.

Momentum transfer through the water surface, waves and surface drift were being measured in the 40m long wind-wave tank at IRPHE, Marseille. In a station in the middle of the tank momentum fluxes were estimated directly through the eddy correlation method to provide reference information for the corresponding surface drift onset recorded at very short fetch. During each experimental run very low wind was set on (about 1m/s) for a certain period and suddenly it was constantly accelerated to reach about 13 m/s (as well as 8 and 5 m/s during different runs) in about 15 sec to as long as 600 sec. The wind was kept constant at that high speed for 2 to 10 min, and then suddenly and constantly decelerate to 0 at the end of each experiment. The 3-d velocity vertical profile is measured with an acoustic sensor (Nortek Vectrino Profiler), with a vertical resolution of 0.1 cm and sampling rate of 100 Hz, over a column of 3.5 cm in length.

Under the highest wind conditions a very distinctive shear was detected in the upper 1.5 cm while the strongest surface drift was recorded as about 0.5 cm/s. A rather linear variation of surface drift was observed with depth under cases of low to moderate wind speed. Evolution of the surface drift velocity is analysed and onset behaviour is addressed with particular emphasis in accelerated winds. A strong surface drift is expected to play a major role in the early stages of surface wave spectrum development, which is to be addressed in terms of frequency spectra estimated from a capacitance gauge deployed in the vicinity of the current profiler.

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